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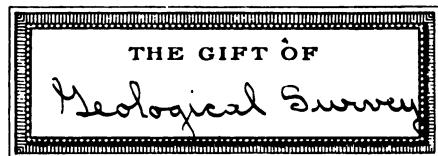
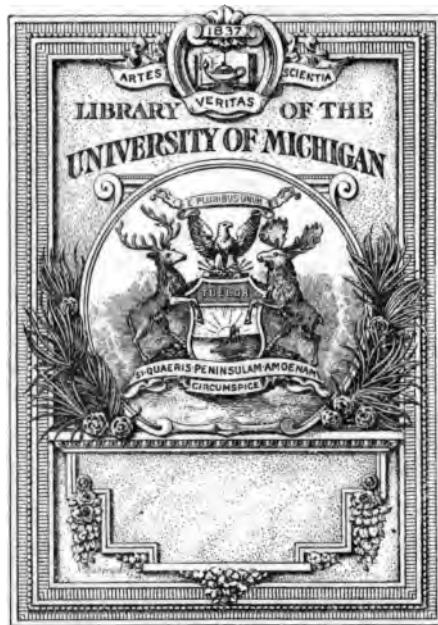
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ILLINOIS  
STATE GEOLOGICAL SURVEY  
BULLETIN NO. 1



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# State Geological Survey

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BULLETIN NO. 1.

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THE GEOLOGICAL MAP OF ILLINOIS

BY

STUART WELLER.

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URBANA:  
UNIVERSITY OF ILLINOIS.  
1906.



**SPRINGFIELD:**  
**ILLINOIS STATE JOURNAL CO., STATE PRINTERS**  
**1906**

STATE GEOLOGICAL COMMISSION

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GOVERNOR C. S. DENEEN, *Chairman*,  
PROFESSOR T. C. CHAMBERLIN, *Vice-Chairman*.  
PRESIDENT EDMUND J. JAMES, *Secretary*.  
H. FOSTER BAIN, *Director*.

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## LETTER OF TRANSMITTAL.

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STATE GEOLOGICAL SURVEY,  
URBANA, ILL., June 20, 1906.

*To Governor C. S. DENEEN, Chairman, and Members of the Geological Commission:*

GENTLEMEN—I transcript herewith the manuscript of a geological map of the State with brief explanatory notes by Dr. Stuart Weller, and respectfully recommend its publication as a bulletin.

It is a well founded practice to begin new work with a careful digest of material already on hand and available. With this thought in mind Dr. Weller was instructed soon after his appointment as geologist of this survey, to compile in the form of a geological map such existing information regarding the formation of the State as might be available. It was believed that such a compilation would throw into sharp relief the areas in which accurate and inaccurate surveys already had been made, and would permit of economical direction of future work. The map herewith transmitted is the result. It will be seen that it is very greatly generalized, and the need of additional detailed work in many portions of the State is evident. The present map, will, however, serve as an excellent base upon which to make corrections as the present survey progresses. Since it will be impossible to cover the entire State with detailed maps for some years, and since no geologic map of the State is now available for general distribution, it is recommended that a small edition be printed for the use of the field parties of the survey, the schools of the State and the persons interested in its mineral resources.

In using this map it should be remembered that it is merely a summary of the best information available at the time of publication. There are probably many and gross errors, which it will be the purpose of the present survey to correct. The map, as Dr. Weller indicates, is based largely on that published some years ago by Dr. Worthen, and the conditions under which the Worthen survey was made, were not such as to permit of the modern degree of detail and accuracy. Geology is a progressive science, and in the years since the older survey was discontinued, study of the geology of the adjacent states, together with the development of more refined methods of research, render it possible not only to make a more accurate, but

a more useful map than formerly was expected. It is proposed from time to time to issue new editions of the present map, incorporating in each such additional data as may be available at the time of publication and suitable to its scale.

The great importance of the coal industry of the State is felt to be sufficient warrant for indicating by separate symbol the shipping coal mines. Their location is taken by the courtesy of Mr. Frank S. Peabody, from the Peabody Coal Atlas, prepared by Mr. A. Bement. Since the coal industry is a very rapidly growing one, it is not improbable that a few of the newer mines have been inadvertently omitted. For such omissions and other inaccuracies the indulgence of the public is asked. It will be a favor if all errors noted, be brought to our attention with a view to correction in future editions.

Respectfully,

H. FOSTER BAIN, *Director.*

## THE GEOLOGICAL MAP OF ILLINOIS.

BY STUART WELLER.

### INTRODUCTION.

*Purpose of a geological map.*—The position of the natural economic products which exist within the crust of the earth in any region, is determined either by reason of the physical conditions present at the time of formation of the rocks in which they are contained, or by reason of subsequent dynamic changes. Thus beds of coal, limestone, sandstone, clay, etc., which may be termed primary economic products, are where they are in the earth's crust by reason of certain peculiar local conditions which have been present in that locality at some past time in the history of the earth; the present position of most metallic mineral deposits, on the other hand, and also of petroleum, is usually determined first, by certain structural features within the earth's crust, such as faults and folds, which have influenced the secondary segregation of these deposits; and second, by the peculiar character and textures of the rocks which are affected by the folding and faulting.

It is the task of the geologist to investigate the ancient history of the earth, to observe the peculiar characters of the rock strata, and to determine if possible the conditions under which they have been formed, also to investigate the changes through which the strata have passed since their deposition. All these observations are recorded graphically upon the geological maps which the geologist constructs. These maps may be of little or of great value from an economic or a historical point of view, dependent wholly upon the accuracy and detail with which the facts of the earth's history are recorded upon them.

*Sources of material.*—The accompanying geological map of Illinois makes no pretense of being an accurate map or of properly differentiating the geological formations of the State. It has been compiled from such published and unpublished data as are available, no field studies having been undertaken in connection with the work. The map is published, in part at least, for the purpose of showing the utter inadequacy of our present geological knowledge of the State in relation to its great natural resources, as well as for the purpose of assisting to point out certain economic and stratigraphic problems which it is desirable that the Geological Survey of the State should

investigate. In order to be serviceable either from the economic or the historical point of view, a geologic map must be constructed with sufficient detail to show with much accuracy the geographic distribution of the various lithologic and historical units, and the relations of these features to the topographic features of the region.

The columnar sections which accompany the map have been compiled from the recorded observations of the earlier Geological Survey, and such additional data as have been found available. These sections are by no means final, and their imperfections are fully recognized. With the prosecution of the work of the present survey, additional data will certainly be secured which will permit the construction of far more accurate sections. In all cases the maximum thickness of the formations has been plotted in the columnar sections.

The sources of the data used in the preparation of the present map have been various. The map published by A. H. Worthen in 1875 and distributed with volume IV. of the reports of the Geological Survey of Illinois has been the primary base. This map itself was based upon a series of county reports made by Worthen and his associates. These taken together constitute a reconnaissance survey of the State. The complete map is exceedingly generalized; the boundaries of the formations recognized were only intended to be relatively accurate. In fact it is frequently difficult to locate exact boundaries because no lines were drawn between the colored areas, and the overlapping colors often cover a belt several miles in width on the scale of the map used.

The map published by Frank Leverett in connection with his report on "The Water Resources of Illinois,"<sup>a</sup> was a second source of information. This is on a much smaller scale than the original Worthen map. In prosecuting his studies of the drift deposits, Leverett visited all parts of the State and was able to modify and rectify the mapping of some of the formations in various localities, his changes being especially noteworthy in the areas of the St. Peters sandstone in the northern portion of the State.

The geologic section across the State prepared by Prof. J. A. Udden in 1892 for the World's Fair Commissioners,<sup>b</sup> has been useful in the preparation of the present map, and has been especially valuable in the construction of the columnar section for the northern portion of the State. This section extends across the State eastward from Rock Island through LaSalle to the Indiana state line, and crosses some or all of the geological formations of each of the Paleozoic periods represented in the State. A paper by O. H. Hershey<sup>c</sup> has afforded data in regard to an area of St. Peters sandstone along Elk Horn creek in western Ogle county. In Whiteside county various modifications based upon unpublished field observations by Mr. G. C. Matson have been incorporated. Perhaps the most notable change from the old Worthern map is to be found in the northwestern portion of JoDaviess county, in an area which has recently been mapped.

<sup>a</sup> U. S. Geol. Survey, 17th Annual Report, part 2, pp. 701-849; map pl. 112.

<sup>b</sup> Report Illinois Board World's Fair Com., pp. 117-151.

<sup>c</sup> Am. Geol., vol. 14, pp. 169-178 (1894).

by the United States Geological Survey in connection with the investigations of the lead and zinc deposits of the Upper Mississippi valley. A comparison of this small accurately mapped area with the adjoining districts shows, perhaps better than anything else, the eminent desirability of a new and reliable map of the State. In the southern portion of the State modifications have also been incorporated on the basis of recent investigations, by the United States Geological Survey, of the fluorspar deposits of Kentucky and Illinois.

In the following discussion of the various units represented upon the map here published, an attempt will be made especially to point out the stratigraphic problems whose investigation is desirable. The geological formations of the state, exclusive of the superficial or Pleistocene formations, range from lower Ordovician to the Tertiary in age. No deposits of Cambrian age, the most ancient period of geological history whose life is abundantly known, are exposed as the surface rock in the state, although they doubtless underlie the younger formations. Although the surface formations range from the Ordovician to the Tertiary in age, not every period in the series is represented; the entire interval from the summit of the Carboniferous to the Tertiary being unrepresented by rock strata unless some Cretaceous beds are present with the Tertiary in the southern part of the state. Furthermore, within the Paleozoic series itself, there are several interruptions or unconformities, each of which represents a time hiatus of greater or less length, during which a part or a whole of the area of the state was above sea level and received no aqueous sediments.

#### LINES OF DEFORMATION.

While in general the rocks of the state are flat-lying or have imperceptible dips, they are not absolutely horizontal. Taken as a whole, the eastern interior coal field, which occupies most of the state, is a great shallow synclinal basin with dips toward the center from all sides. These dips can be measured only in feet per mile. There are, however, a few lines along which the dips are reversed, so that there are certain rather poorly defined anticlinal areas. These have not yet been carefully worked out, though the more important ones are noted below.

At least six distinct lines of structural deformation is exhibited in the folding and faulting of the strata. All of them have a northwest-southeast trend, although three are more nearly east and west. Most of them are within the southern half of the state.

The northernmost of these lines crosses into Illinois near Savannah, but is best developed in Jackson county, Iowa. The most important deformation line crosses the Illinois-Wisconsin boundary in Stephenson county, and continues with a direction of about 23 degrees east of south, crossing Rock river at Grand Detour and the Illinois between La Salle and Utica. This line seems to be a simple anticlinal fold, with the southern limb much the steeper. It brings small areas of the Lower Magnesian limestone and larger areas of

the St. Peter sandstone to the surface in Cole county, and again in La Salle county. This fold continues southeastwardly beyond the Illinois river, but the rock surface of this portion of the state is so deeply buried by drift that it is not easy to follow such a line of deformation. A well drilled at Tuscola<sup>a</sup> to a depth of 792 feet, seems to show the entire absence of Coal Measure strata at that point, which would indicate the presence there of the axis of the fold. To the southeast of Charleston an oil field of considerable area is being developed, which is probably associated with the southward continuation of this La Salle anticline, as it may be called.

The occurrence of the areas of older rocks in the northern portion of the state, not in a continuous area of outcrop but in a series of outcrops isolated one from the other, suggests the possibility of a series of folds transverse to a major northwest-southeast axis, the outcropping areas being at the intersections of the axes. This problem, however, is one which needs further investigation.

The third line of deformation crosses the Mississippi river in southern Calhoun county with a direction of about 10 degrees south of east. It crosses the Illinois river a few miles above its mouth, into Jersey county, but soon strikes the Mississippi again by reason of the eastward bending of that stream, and following the course of the river is soon lost. It is not improbable that additional observations will demonstrate the continuation of this line of deformation further to the eastward than it is now recognized. Where this line crosses the Mississippi river from Missouri into Calhoun county, it is marked by a fault having a throw of about a 1,000 feet, the St. Peter's sandstone of the Cap au Grés bluff being brought to the surface by the upthrust to the north, the strata on the southern side of the fault line being the Mississippi limestones. According to the reports of the former Geological Survey, this fault is rapidly transformed into an anticlinal fold to the eastward, faulting having entirely disappeared where the line crosses the Illinois river into Jersey county.

The fourth line of deformation, and perhaps the slightest of the six here recorded, is recognized in the Mississippi river bluffs of southern St. Clair county. It has a direction of 20 degrees east of south, but cannot be traced any considerable distance because of the deep mantle of drift present in that portion of the state away from the Mississippi river bluffs. The deformation is in the nature of an anticlinal fold, the northeastern limb having a very gentle dip of from 20 degrees to 30 degrees.

In the extreme southern portion of the state, two anticlinal axes are recognized, which pass from the Mississippi river on the west to the Ohio river on the east. The first of these passes from near the mouth of Big Muddy river in the direction of about 7 degrees south of east, crossing the Ohio above Elizabethtown. At the west Devonian and Silurian rocks are brought to the surface, while eastwardly the Mississippi limestones form the axis of the anticline, with a small area of Devonian black shale in Hardin county. This axis stands up as a prominent ridge about ten miles in average width, the crest being

from 700 to 800 feet above sea level, or about 300 feet above the adjoining regions to the north and south of it. In Pope and Hardin counties H. F. Bain<sup>a</sup> has recognized several faults, more or less transverse to this axis, which were doubtless formed at the time of the anticlinal folding. Much more extensive faulting of a similar sort has been mapped by E. O. Ulrich<sup>b</sup> in the adjoining area across the Ohio river in Kentucky. Similar faulting will doubtless be recognized further west along this axis in more detailed study of the region, which will more or less modify the stratigraphic interpretations of the older survey.

The southermost deformation axis which has been recognized, passes from the vicinity of Thebes with a direction of about 7 degrees south of east to Grand Chain on the Ohio river. At Thebes this elevation brings the rocks of Trenton age to the surface, where they form in the Mississippi river a reef which at times is dangerous to commerce. Eastwardly this axis is buried beneath the Tertiary formations, but at Grand Chain on the Ohio river a reef similar to that in the Mississippi is recognized.

Further detailed work will doubtless bring to light other lines of deformation, as well as give us far more accurate knowledge of these here recognized. In the earlier interpretations of the stratigraphy of the state, the faults were recognized in only a few instances. This type of deformation, however, is doubtless far more prevalent than would be indicated by the present mapping of the state, and its recognition, in connection with future work of the survey, will doubtless frequently alter older interpretations. The occurrence of petroleum and natural gas at various localities in the state is probably associated with anticlinal folding of the strata.

## GEOLOGICAL FORMATIONS.

### CAMBRIAN.

*Potsdam sandstone*—This formation belongs to the most ancient of the great periods of the earth's history, which are represented by sediments in the crust of the earth, bearing an abundance of organic remains. This period is known as the Cambrian, and the "Potsdam sandstone," so-called in the upper Mississippi valley region, represents some part of the middle and upper Cambrian. The formation is nowhere exposed at the surface in Illinois, but it has been penetrated in several deep wells in the northern portion of the State, the greatest thickness observed in this manner being about 1,000 feet, but nowhere has the bottom of the formation been reached. The formation extends northward beneath the younger formations, being exposed as the surface formation over considerable areas in Wisconsin; it doubtless continues southward underlying the entire State of Illinois, although it is not improbable that its lithologic characters change more or less. Where the formation is best known, in Wisconsin, it is most commonly a yellowish sandstone. Because of its great lateral extent and its porous character, it constitutes a reservoir from which an abundant supply of water can be obtained.

<sup>a</sup> Bull. U. S. Geol. Surv., No. 255, pl. 2.

<sup>b</sup> Prof. Pap., U. S. Geol. Surv., No. 36, pl. 2.

## ORDOVICIAN.

*Lower Magnesian limestone*—This formation comprises the most ancient beds exposed in the State, and in its surface outcrop is more limited than any other division recognized upon the map. The largest exposed area is along the Illinois River in the neighborhood of Utica, in LaSalle county, where the formation outcrops for about two miles in the bluff on the north side of the river. Other small areas are known in LaSalle county along the Little Vermilion river and Tomahawk creek north of LaSalle. Outside of LaSalle county the formation is known only in western Ogle county, where it outcrops for several hundred yards along the south bank of Elk Horn Creek.<sup>a</sup> Certain beds of this formation are used in the manufacture of natural cement at Utica.

Although this formation is so limited in the area of its surface exposure, it is by no means an unimportant geological formation in Illinois. Like the subjacent Potsdam sandstone it doubtless underlies the entire area of the State. The deep wells in northern Illinois which have penetrated the Potsdam sandstone have all passed through the Lower Magnesian limestone, and the formation can be best studied in the section across northern Illinois prepared by Udden. Observations of the deep well data along the line of this section show that the formation increases regularly in thickness from east to west, being approximately 450 feet at the Indiana state boundary, while at Rock Island a thickness of 811 feet is recorded.

*St. Peters sandstone*—The surface outcrops of the St. Peters sandstone are confined almost entirely to the northern portion of the State, where it is usually a soft, white or light colored, incoherent sandstone. Two principal areas are recognized, in the first of which the formation is well exposed along the Illinois river from east of LaSalle to the mouth of Fox river, and is continued up the valley of Fox river for some distance, with a small detached area still higher up the same valley in the edge of Kendall county; in this same area the formation extends for some distance up the valleys of the Vermilion and the Little Vermilion rivers which empty into the Illinois at LaSalle. The second large area lies to the northwest of the one already mentioned, in Lee and Ogle counties, in the valley of the Rock river from a short distance above Dixon to beyond Oregon, and up the valleys of the chief tributaries of this stream in this area. Besides these larger areas there is a small area in the western part of Ogle county where this formation is the surface rock, which was first described and mapped by Hershey.<sup>b</sup> According to Leverett, this formation also extends down the valleys of the Rock and Pecatonica rivers from the Wisconsin state line as far as the cities of Rockford and Freeport. In these valley areas, however, although this formation is apparently the underlying rock, it is so deeply covered by glacial deposits that no outcrops of it are anywhere exposed; neither of these valley areas exceed one or two miles in width. Besides these

<sup>a</sup> Hershey, Am. Geol., vol. 14, p. 170.

<sup>b</sup> Am. Geol., vol. 14, pp. 169-179.

<sup>c</sup> Private communication.

areas of the St. Peters sandstone in the northern portion of the State, there is only one exposure of the formation in Illinois, and that a small one in Calhoun county on the bank of the Mississippi river where this formation forms the southern extremity of the Cap au Grés bluff. To the north from this exposure the formation dips beneath the younger strata, and to the south it is cut off by a fault which crosses the Mississippi at this point and continues in an easterly direction across the Illinois river into Jersey county. The maximum thickness of this formation in the State, as shown in deep well records, is 275 feet, although near Utica, where its best exposure may be seen, its thickness is apparently about 150 feet.

Like the two preceding formations, the St. Peters sandstone has a much greater distribution than is indicated by its limited surface exposures. The formation as exposed in Calhoun county, is, without doubt, continuous beneath the younger strata with the beds exposed in northern Illinois, and it is not improbable that the formation underlies the entire State. The formation is eminently porous and is freely penetrated by the underground waters, and is of great economic importance as a reservoir from which an abundance of water may be secured by means of deep wells.

*Trenton-Galena formation.*—In future geologic mapping of the State, this unit will undoubtedly be divided. As now mapped the division includes all the calcareous and dolomitic beds between the St. Peters sandstone below and the usually shaly or arenaceous Cincinnati beds above. In the northern portion of the State the formation has a thickness of from 300 to 440 feet, as shown in deep well records where the entire thickness of the formation has been penetrated; in the central portion of the State where the formation is exposed in Calhoun and Jersey counties, about 400 feet have been recognized; in southern Illinois the entire thickness of the formation is nowhere exposed, only about 100 feet of the uppermost beds being known, this being the oldest formation exposed.

In the northern portion of the State the Galena limestone is a good lithologic unit and should be considered as one unit for the purpose of mapping; it is the essential equivalent of the typical Trenton limestone of the New York section. The underlying 50 to 100 feet of strata are fundamentally different, both lithologically and paleontologically, and should be represented by a distinct color upon any future geological maps. In the older reports of the State, the lower beds were incorrectly considered as representing the typical Trenton, the Galena being considered as a higher formation, and they were designated as the "buff" and the "blue" beds.

In the southern portion of the State the lithologic characters of the strata contemporaneous in age with the Galena-Trenton beds of the north are quite different. Instead of the conspicuous dolomitic limestones, purer limestones are the rule, and furthermore, although they are doubtless contemporaneous in age, the fossil faunas which characterize the strata in the northern and southern portions of the State, are quite different. These two regions represent what is known to the geologist as two distinct geologic provinces, and it is important both economically and historically, to determine the true relations of

these provinces, their boundaries, the different physical conditions which have existed in them and the reasons for such differences. In the solution of such problems as this the application of paleontology to geology, or applied paleontology is of utmost importance, for the reason that the life which has existed or which still exists in any given region, is one of the most delicate indices of the physical conditions which there obtain. The study of such problems as this, concerning the ancient geologic provinces of the interior of North America, has only just begun, and the investigations of the survey should contribute data of great value towards the solution of these general problems.

The known areas of the Trenton-Galena formations in the southern portion of the State are small and are limited chiefly to three regions, the first in Calhoun county, with a single exposure east of the Illinois river in Jersey county, the second in western Monroe county, and the third in western Alexander county. Besides the known exposures, however, these formations have a wide distribution beneath the younger rocks, perhaps underlying the entire State aside from the areas where older strata are exposed at the surface.

*Cincinnatian formation.*—In connection with the future investigation of the Cincinnati beds in Illinois, one highly important stratigraphic problem must be constantly kept in mind. Recent paleontologic investigations have shown that at least a large part or perhaps all of the beds of Cincinnati age in the Mississippi valley region west of the Cincinnati anticline, correspond paleontologically with the uppermost or Richmond division only of the Cincinnati as it is developed in the typical region in the Ohio valley; the Lorraine and Utica divisions being entirely absent. This fact suggests that west of the Cincinnati anticline there is a widespread pre-Richmond unconformity. Such an unconformity and stratigraphic break has not been generally recognized in the Mississippi valley, but a post-Richmond unconformity has been quite generally assumed, although with no very definite field evidence. Locally a pre-Richmond unconformity can be clearly recognized, but in other localities there is apparently no stratigraphic break at this horizon; there are also localities in the same region where the Richmond faunas seem to blend with the overlying Silurian faunas as in the Cape Girardeau limestone in southern Illinois and Missouri, a fact which, in the absence of any definite post-Richmond stratigraphic uniformity, suggests that this generally assumed stratigraphic break may be without sufficient foundation. This problem cannot be solved in Illinois alone, but the investigations in this State can contribute important data towards its solution. The problem is of far-reaching importance in historical geology, in that it may ultimately involve the question as to the proper position of the boundary line between the Ordovician and Silurian systems.

The solution of the problem of the Richmond, at least in the northern portion of the State, is made more difficult by reason of the shaly nature of the beds, the contacts, especially the most critical one between this formation and the underlying beds, usually being too poorly exposed to admit of close stratigraphic study.

The beds of Richmond age possess exceedingly variable lithologic characters in different portions of the State. In the north they are chiefly calcareous shales or shales with thin bands of dolomite and limestone interbedded, and are frequently fossiliferous. The formation includes the Maquoketa shales of the Iowa geologists, a formation which is one facies of the more general Richmond, and which is strongly developed in the region of Dubuque, Iowa, extending into northeastern Illinois and recognized also in the Mississippi valley to a point some distance south of St. Louis. In the southern portion of the State, near Thebes, in Alexander county, the Cincinnati beds of Richmond age are represented by sandstones and shales, and by the Cape Girardeau limestone. In future mapping in the State on a larger scale, it may be found expedient to recognize more than one cartographic unit where now all the beds are designated by a single color. In thickness the formations of this age vary from 40 to 250 feet, and they are doubtless continuous beneath the younger formations throughout the entire State.

#### SILURIAN.

*Niagaran limestone.*—In northern Illinois the Silurian period is represented by a single great dolomitic limestone formation which has always been referred to in the literature of the State as the "Niagara limestone." This formation, however, does not correspond exactly with the Niagara, or as it is now called, the Lockport limestone of the New York section, but probably represents a much longer time interval. The stratigraphic relations of this formation to the underlying Cincinnati beds should be carefully studied for its bearing on the Richmond problem already mentioned, and the distribution of the fossil faunas within the formation should be investigated for its bearing upon the correlation of the formation with the Silurian beds in other portions of the country, and for the purpose of determining the relations of the geologic provinces of Silurian time in the Mississippi valley. In the Silurian as in the Ordovician, there was apparently a distinct northern and southern province in the interior of North America, although little is known as to the relations between the provinces. In one respect at least, there is a striking parallelism between the provinces during these two periods, and that is in the presence of highly dolomitic beds in the northern and more calcareous beds in the southern province. In both cases, accompanying the differences in the lithologic characters of the sediments, there are distinct differences in the fossil faunas. Comparatively little is known at the present time in regard to the conditions which have produced the extensive dolomitic formations of the earth's crust, and because of the great development of such formations in the northern portion of Illinois, and their great economic value, it will come within the scope of the survey to investigate in considerable detail the conditions of their formation.

Like all the preceding formations in the State, the Niagara rocks are probably continuous beneath the younger formations except along

their northern boundary, where the Coal Measure rocks overlap to some extent. In north-western Illinois the Niagaran limestone occupies a great area extending from central Iroquois county to the Wisconsin state line, and at the north-west it occupies considerable areas in the valley of the Mississippi and its tributaries, the total thickness of the strata in this region being from 300 to 388 feet. In Jersey and Calhoun counties these rocks again come to the surface in the valleys of the Mississippi and Illinois rivers, north of the Cap au Grés fault, with a thickness of from fifty to a 120 feet. At Grafton the formation is dolomitic, as in the northern provinces which suggests that the boundary between the northern and southern provinces during Silurian time was further south than during the Ordovician. In this whole northern and central region the formation is overlain unconformably by strata of considerably younger age.

In the southern portion of the State, in Jackson, Union and Alexander counties, there is a considerable area indicated as Silurian on the accompanying map which needs further careful investigation. In the old reports these beds were referred to as the "Lower Helderberg limestone;" they are entirely different from the Niagaran of the northern portion of the State, both lithologically and faunally, and certainly belong to a distinct southern province. A portion of these southern strata are perhaps truly of Silurian age, but it is more than probable that a large portion of the beds are younger and should perhaps be referred to the lower division of the succeeding period, the Devonian. The maximum thickness of the beds is about 250 feet.

#### DEVONIAN.

Strata of Devonian age form the surface rock at three widely separated regions in the State. The first of these is in Rock Island county, where the rocks have a maximum thickness of about 150 feet, although not more than about seventy-five feet are exposed, the total depth of the formation being known only from deep well records. These strata are of middle and upper Devonian age, are mostly limestones and are frequently filled with fossil remains which indicate their relationship to that geologic province of Devonian time which extended off to the north-west into Iowa and beyond. The second Devonian area is in Calhoun and Jersey counties, where there is scarcely more than ten feet of limestone of this age, the faunas which they contain show that these beds also belong to the north-western Iowa province. The third area is in the southern portion of the State, in Jackson, Union and Alexander counties; the beds are chiefly limestones and sandstones and the contained fossil faunas of middle Devonian age show that they belong to a totally different geological province than the beds farther north, their relationships being with the Devonian formations to the eastward in the Ohio valley and even New York.<sup>a</sup> In this southern area there is also a considerable series of lower Devonian strata of totally different age from any of the strata further north. Further investi-

<sup>a</sup>Weller, S., Jour. Geol. vol. 5. pp. 625-635.

gation will doubtless show that a considerable portion of the area referred to the Silurian on the accompanying map in these southern counties, is really of lower Devonian age, as has already been indicated.

Besides these three chief Devonian areas, the remnants of formerly existing Devonian formations have been noticed near Chicago,<sup>a</sup> preserved in joint cracks of the Silurian limestone, sometimes as much as twenty feet below the upper surface of the Silurian formations. These joint fillings are dark colored and arenaceous, and their age is indicated by the fossils, chiefly fish teeth, which they contain. The most notable of these Devonian remnants occurs at Elmhurst, but a similar crack filled with Devonian materials has been observed in the quarry at Lyons. The faunal relationships of these fish teeth near Chicago is with the Devonian faunes of Iowa and also with those from near Milwaukee, Wis.

The deep-well data recorded by Udden in his geologic section indicate the presence, through a considerable area west of LaSalle, of a calcareous and shaly formation varying from 40 to 100 feet in thickness lying between the Niagaran limestone and the Coal Measures. This is probably Devonian in age, although no fossils are known. The extent of this area in a north and south direction is uncertain.

In the south-eastern portion of the State, a small area of Devonian black shale is indicated, which has been detected recently in connection with the work of the United States Geological Survey in that portion of the State.

Unlike the preceding formation, the Devonian rocks do not extend continuously throughout the State beneath the younger formations. In the first place, it is not certain that the Devonian sea entirely covered the area of the State, at least contemporaneously, and in the second place, a considerable portion of the State was elevated above sea level at the close of Devonian time, and those Devonian rocks which had been formed were eroded wholly or in part before the transgression of the sea brought about the formation of younger sediments. The remnants of sediments of Devonian age found in the joint cracks of the Niagaran limestone near Chicago, indicate the former greater extension of formations of this age, as also do the Devonian beds recognized in the deep well sections west of La Salle. The Devonian area of the Rock Island region is probably continuous with the strata of the same age in Calhoun and Jersey counties, but this northern and central area is probably not connected beneath the younger formations with the Devonian area of the southern portion of the State.

#### CARBONIFEROUS.

*Mississippian limestone.*—The area colored as Mississippian on the accompanying map, extends nearly the entire distance from Mercer to Jackson counties along the Mississippi river and across the southern portion of the State from Union to Hardin counties. This unit is a very complex one, and in any future mapping five or more distinct divisions must necessarily be recognized and mapped. In its present condition the map is of little value, either from the

<sup>a</sup> Weller, S., Jour. Geol., vol. 7, pp. 483-488.

economic or the historical standpoint. During this period, as during the earlier ones, there was a marked difference in the conditions of the northern and southern portions of the area, again indicating two distinct provinces,

In the county reports of Illinois, published under the direction of Worthen, these Mississippian or Lower Carboniferous limestones as they were then called, were divided into five groups, as follows:

5. Chester.
4. St. Louis.
3. Keokuk.
2. Burlington.
1. Kinderhook.

The two uppermost of these divisions have their greatest development in the southern portion of the State, while the three lower ones are the most strongly developed in the north. The St. Louis is, perhaps, the most widespread; extending throughout the entire region of Illinois and the neighboring states.

This older classification represents the general relations of the Mississippian formations. It is not sufficiently complete, however, for the purposes of modern geological studies, and Ulrich<sup>a</sup> has recently suggested a more critical classification of the beds which is represented in the following table.

*Ulrich's Classification of the Mississippian.*

MISSISSIPPAN.	TENNESSEAN.		Kaskaskia limestone.	Birdsville formation.....	Kaskaskia limestone of Hall, Chester limestone of authors, Huron formation of recent Indiana reports is same as Birds-ville formation.	
				Tribune limestone .....		
WAVERLYAN.	Chester Group.		Cypress sandstone.....	Aux Vases sandstone of Keyes. Probably also Big Clifty sandstone of Norwood.		
				Two upper members referred to as lower Chester by Worthen and Englemann. Entire formation referred to as St. Louis by Norwood.		
WAVERLYAN.	Meramec Group.	St. Louis limestone .....	Ohara limestone... Ste. Genevieve limestone.... Rosiclare sandstone.... Fredonia oolitic limestone....	St. Louis limestone of most authors, but not of Englemann, Shumard, and Swallow, who do not include two lower formations in the St. Louis limestone. The two upper formations equal, respectively, the Mitchell limestone and the Bedford oolitic limestone of recent Indiana reports.		
				Keokuk limestone .....		
WAVERLYAN.	Osage Group.	Tullahoma formation.....	Burlington limestone...	Burlington limestone...		
				Various formations of the Kinderhook group.		
WAVERLYAN.	Kinderhook Grp.	Tullahoma formation.....	Various formations of the Kinderhook group.	Harrodsburg limestone (typical) and Knobstone of Indiana.		

These divisions recognized by Ulrich have been used as a basis for mapping done by the United States Geological Survey in the fluor-

<sup>a</sup> U. S. Geol. Surv., Prof. Pap., No. 36, p. 24.

spar district of western Kentucky and southern Illinois, and this or some modification of it will doubtless be found to be applicable in mapping other portions of the Mississippian area of the State, although it still remains to be seen through future investigations, how widespread an application it may have.

*Coal Measures.*—No geologic formation in Illinois contains greater economic resources than the Coal Measures. Here are to be found the enormous coal resources which exceed all other mineral products of the State combined, besides great deposits of clay, usually in the form of shales, and less important beds of limestone and sandstone. All of these products are being utilized to a greater or less extent at the present time, Illinois being the second State in the Union in the production of coal, but their future development is destined to be vastly more extensive. The investigations of these formations by the Geological Survey, and their accurate mapping will undoubtedly prove to be of inestimable value to the citizens of the State.

In the present geological map of the State the Coal Measures or Pennsylvanian rocks are arbitrarily divided into two series, the "Lower" and the "Upper" Coal Measures, which together attain an aggregate thickness approximating 1,200 feet in some portions of the State. The former Geological Survey recognized sixteen different coal seams in the entire series, ranging in thickness from one to nineteen feet, and separated by greater or less thickness of shales, sandstones and limestones. It has usually been assumed that these seams were continuous throughout the area of the State occupied by the Coal Measure strata, except where the higher ones may have been removed by erosion. More recent investigations in neighboring states, notably in Indiana and Iowa, have shown that the coal seams in these states are not continuous beds over great areas, but that they are local, more or less lenticular bodies having a more or less limited geographic extension. It is of course possible that the conditions are somewhat different in Illinois, and that the seams are more nearly continuous, this being the more central portion of the great Mississippi valley coal field as a whole. It is, however, a matter of great importance, in the development of the coals, to determine with certainty the actual facts in regard to their distribution. These facts, in so far as they can be determined by a study of the natural outcrops of the formations, and of the sections shown in shafts and drill holes, will be recorded on the new geological maps to be constructed by the survey. These maps will be made in much greater detail than the one here presented, and many smaller formations will doubtless be recognized.

One of the important horizons to be studied in this connection, and accurately mapped in the coming investigations of the survey, is a limestone known locally as the "Carlinville" or "Shoal Creek" limestone, which was supposed by Worthen to occupy about the middle position in the entire Coal Measure series, and was used by him to indicate the boundary between the "lower" and "upper" Coal Measure series. If it can be shown that this is actually a continuous limestone formation which can be traced through a considerable por-

tion of the Coal Measure area of the State, it will be of great value as a reference horizon to be used in mapping the overlying and underlying strata of coal, shales, sandstones and limestones.

The northeastern border of the area colored as Upper Coal Measures on the accompanying map, is drawn arbitrarily along the supposed southeastward extension of the anticlinal axis which has elevated the older Ordovician formations, the Lower Magnesian limestone and the St. Peters sandstone in Ogle, Lee and LaSalle counties. In the present map this line is drawn farther to the west in its southern extension than in the original Worthen map. This change has been made on account of data secured from well boring at Tuscola and near Urbana, made since the publication of that map,<sup>a</sup> and because of data more recently obtained from the development of the oil fields southeast of Charleston which seem to be associated with the extension of the LaSalle anticline. Nearly the entire area through which this line is drawn, is so deeply covered with drift that no rock outcrops are anywhere exposed, and the distribution of the underlying formation can only be determined through the records of deep well borings which are all too few.

*Permian*.—No Permian rocks have been indicated upon the accompanying map, although a small exposure is known to exist in Vermilion county. This locality has afforded an exceedingly interesting series of vertebrate fossils which have been studied first by Cope and later by Case.<sup>b</sup> The strata themselves, so far as present evidence is available, were deposited in an ancient river valley of Permian age, which flowed across the old Carboniferous surface, and along whose banks these early representatives of the Amphibians and Reptiles flourished. A more careful investigation of these beds than any which has yet been made should be undertaken by the Survey, in order to ascertain the distribution of this highly interesting formation.

#### CRETACEOUS.

No Cretaceous strata, certainly known as such, are exposed as the surface rocks anywhere in the state. Some of the beds in the southern portion of the state now usually referred to the Tertiary, have sometimes in the past, been supposed to be Cretaceous on insufficient evidence. However, a specimen of *Exogyra costata*, a highly characteristic Upper Cretaceous bivalve mollusk, is reported to have been secured during the excavation for the piers of the Illinois Central railroad bridge across the Ohio river at Cairo,<sup>c</sup> and if this report is well founded, it is not improbable that beds of Cretaceous age underlie at least some portion of southern Illinois.

#### TERTIARY.

The northern extremity of the great Tertiary Mississippi embayment reached as far north as southern Illinois, and sediments of Ter-

<sup>a</sup> Geol. Surv. Ill., vol. 8, p. 25.

<sup>b</sup> Jour. Geol., vol. 8, pp. 698-729.

<sup>c</sup> Rep. Ill. Board World's Fair Com. p. 217.

tiary age occupy a narrow strip across the state in southern Alexander, Pulaski and Massac counties. The sediments lie unconformably upon Paleozoic formations ranging from Ordovician to Carboniferous in age; they consist of stratified sands and clays overlain by a ferruginous conglomerate of siliceous pebbles. In Pulaski county there is a bed of glauconitic sand associated with these formations, which has sometimes been considered to be of Cretaceous age because of its lithologic similarity to certain Cretaceous beds in the east. Fossils are not abundant in any of these formations, in fact they are almost entirely absent, so that the definite determination of their age is a matter of some difficulty.

North of the continuous area of these strata, there is present upon the summits of some of the highest hills in Union county, a capping of ferruginous conglomerate similar to that further south, which marks a former extension of the same formation. Still further north, in Hancock county, Worthen has reported the presence at one or two localities, of a similar ferruginous conglomerate at the base of the drift, but these occurrences are so far distant from the Tertiary outcrops in the southern portion of the state, that it is not safe to consider them of Tertiary age without further careful investigation.

Besides these exposures of conglomerate mentioned above, certain fossils have sometimes been met with in the drift deposits of the northern portion of the state, which have sometimes been interpreted as indicating the presence of isolated, drift covered areas of Tertiary or Cretaceous strata in the Mississippi valley as far north as Henderson county. These fossils are probably all of Cretaceous age and are doubtless not of local origin but have been transported by the glaciers to the place where they have been found, from the Cretaceous regions of the northwest.

#### PLEISTOCENE.<sup>a</sup>

Throughout the greater portion of the State the surface is more or less deeply covered with glacial deposits of Pleistocene age, which add greatly to the difficulty of interpreting the stratigraphy of the older underlying rocks. In the north-western portion of the State is a driftless area comprising the greater portion of Jo Daviess county, with portions of Stevenson and Carroll counties, and in Southern Illinois the drift does not extend south of the conspicuous ridge which crosses the State from near Grand Tower to a point north of Elizabethtown. These glacial deposits are variable in their lithologic characters, consisting of unstratified glacial till, stratified sand and gravel deposits, loess and alluvium. In Southern Illinois, to about the latitude of St. Louis, the drift deposits are usually scarcely thirty feet in thickness and have not obscured the underlying rock surface sufficiently to have greatly changed the principal preglacial lines of drainage, but north of this area the drift is much thicker, sometimes exceeding 150 feet, so that with the exception of the bluffs along the

<sup>a</sup> For a fuller consideration of Illinois see, "Water Resources of Illinois," by Frank Leverett, U. S. Geol. Surv., 17th Ann. Rep., p. 706. "Illinois Glacial Lobe," mon. 38.

larger streams the underlying rock surface is usually completely obscured. The average thickness of the drift for the entire glaciated portion of the State is about seventy-five feet.

#### IGNEOUS ROCKS.

The presence of igneous rocks in Illinois has been recognized only recently, and so far as known they do not occur outside of Pope and Hardin counties in the south-eastern portion of the State. The occurrence of these rocks is in the form of dikes which have been intruded into the Mississippian limestones.<sup>a</sup> These intrusives are greatly altered, and so far as can be determined fall into two groups, mica-peridotites and lamprophyres, the latter group including the majority of the specimens. The position of these dikes, so far as they are known, has been indicated upon the accompanying map, although it has been necessary to exaggerate them considerably in order to show them on a map of this scale.

<sup>a</sup>For a more detailed discussion of these intrusives see "The Fluorspar Deposits of Southern Illinois," by H. F. Bain, Bull. U. S. Geol. Surv., No. 238, pp. 57-90.

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